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NOLTR 65-111

19

EXPLOSIVE PROPERTIES AND HANDLING CHARACTERISTICS OF HNS-I (U)

25 FEBRUARY 1966

NOL

UNITED STATES NAVAL ORDNANCE LABORATORY, WHITE OAK, MARYLAND

NOLTR 65-111

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EXPLOSIVE PROPERTIES AND HANDLING CHARACTERISTICS OF HNS-I (U)

By
E. Eugene Kilmer

ABSTRACT: The terminating explosive components used with heat resistant mild detonating fuse (MDF) should contain explosives of comparable heat resistant properties. One explosive for this use is hexanitrostilbene (HNS-I). It is sufficiently insensitive to heat, impact, and electrostatic spark to be used in MDF end couplers and end boosters. It has acceptable detonation velocity and sensitivity for these uses.

EXPLOSION DYNAMICS DIVISION
EXPLOSIONS RESEARCH DEPARTMENT
U. S. NAVAL ORDNANCE LABORATORY
WHITE OAK, MARYLAND

NOLTR 65-111 25 February 1966

EXPLOSIVE PROPERTIES AND HANDLING CHARACTERISTICS OF HNS-I (U)

This is one of the reports on "The Investigation of High and Low Temperature Resistant Explosive Devices" work being conducted for NASA Manned Spacecraft Center at Houston, Texas under Task NOL-787. Related work leading up to this study was sponsored by the FBM Evaluation Committee of the U. S. Naval Ordnance Laboratory under assignment from the Special Projects Office, Bureau of Naval Weapons (References 1 through 4). This work is being carried out to investigate new heat resistant explosives and to determine their usefulness in explosive components for future space programs like APOLLO. This report discusses Hexanitrostilbene (HNS-I) and its explosive properties.

The identification of commercial materials implies no criticism or endorsement by the U. S. Naval Ordnance Laboratory.

J. A. DARE
Captain, USN
Commander

C J Aronson

C. J. ARONSON
By direction

CONTENTS

ILLUSTRATIONS

INTRODUCTION

1. Previous efforts have indicated a need in the NASA Apollo Program and the Navy, Air Force, F-111 Airplane for a mild detonating fuse (MDF) end booster[1-6].* HNS-I, a heat resistant explosive, has been used successfully in the end booster. A typical end booster is shown on Figure 1. This report presents the handling and detonation properties of the hexanitrostilbene (HNS-I)**. These properties include determinations of: the detonation velocity in various explosive column diameters, the impact sensitivity, the electrostatic spark sensitivity, and the chemical stability. HNS-I is now being used in the F-111 Aircraft Crew Module[6].

EXPLOSIVE LOADING AND FIRING PROPERTIES OF HNS-I

Chemical, Crystal and Handling Properties

2. The chemical properties of HNS-I have been reviewed in reference 7. The color of the HNS-I crystals varies with particle size, but it is normally a yellow-brown. A photomicrograph of HNS-I is shown in Figure 2. The particle size is about 10 microns with an appreciable number of smaller crystals. These small particles agglomerate, but break up easily on handling. However, they do tend to pick up a static charge and stick to handling tools. Handling is facilitated by maintaining the relative humidity in the loading area at 65 to 70% RH. This is contrary to the humidity conditions for handling of HNS-R, Figure 3, and DIPAM which handle best at between 40 and 45% RH.

Impact Sensitivity

3. The 50% impact height of HNS-I (X-498)***, using sandpaper, the NOL-ERL machine with Type 12 tools, and a 2.5 Kg weight, is 47 cm. This is based on a 25 shot Bruceton run. HNS-I is less sensitive than tetryl (50% impact height 40 cm) and should be safer to handle during loading operations.

* References may be found on page 4.

**HNS-I is a superfine (<10 microns) HNS obtained directly in the chemical synthesis from the mother liquor.
HNS-R is an HNS recrystallized slowly from bulk HNS.
HNS-II is an HNS obtained by refluxing a mixed solvent and bulk HNS and recrystallizing HNS from the solvent in the pot.

***NOL sample identification number.

Electrostatic Spark Sensitivity

4. It is important to know the electrostatic spark sensitivity of explosives when they are to be handled in bulk form. The test method and equipment described in NAVORD Report 6632[8] was used to determine the static spark sensitivity of HNS-I. Data for HNS-I, HNS-R, and RDX and PETN are given in Figures 4, 5, and 6 respectively. More testing is planned at the lower capacitance, higher voltage levels which more closely simulate human charge characteristics. We judge from the results so far obtained that HNS-I and HNS-R require only the ordinary precautions against static electricity that are appropriate for handling intermediate and high explosives.

DETONATION PROPERTIES OF HNS-I

Small Scale Detonation Velocity Test

5. Detonation properties of HNS-I were determined in several small scale tests combining the effects of column diameter, charge density, and detonation velocity. This information is necessary particularly if the explosive is to be used in mild detonating fuse, flexible linear shaped charge, and small diameter explosive components such as end couplers and end boosters. The small scale detonation velocity test[9] was used. Confinement was in steel bodies. The explosive column diameters were 0.30 inch, 0.20 inch, and 0.10 inch. A plot of the small scale detonation velocity of HNS-I as a function of its density and column diameter is shown in Figure 7. The detonation velocity is about the same as that of HNS-R which is 6.9-7.1 mm/µsec at a density of 1.7 g/cc. DIPAM has a detonation velocity of about 7.4 mm/µsec at a density of 1.7 g/cc.

Small Scale Gap Test

6. This test uses an arbitrary configuration to study the transfer of detonation between small-diameter charges[10]. The charges are loaded in heavy-walled brass containers. The initiating shock is derived from an RDX-loaded donor. The shock strength is varied by changing the thickness of lucite interposed between the donor and the acceptor. The acceptor explosive, in powder form, is pressed into the acceptor at a pressure which will give the desired density. The data are reported in units of DBg (Gap Decibang):

$$DBg = 30 - 10 \log (\text{observed gap in mils}).$$

The dent in a steel witness block is used to judge whether or not the acceptor was initiated.

7. Five 20-shot Bruceton tests were run with HNS-I. The acceptors were pressed at 4, 8, 16, 32, and 64 KPSI. The results have been plotted in Fig. 8. The results for several other explosives are shown for comparison. From the results, it may be seen that HNS-I is less sensitive than HNS-R but has about the same sensitivity as DIPAM. From these results, and those from the impact and static sensitivity tests, it was judged

that HNS-I could be handled and loaded safely and that it can be properly used beyond the interrupter in fuze trains.

Output

8. The explosive vigor of HNS-I was obtained by the steel dent test as an adjunct of the small scale gap test. The output of HNS-I is compared in Figure 9 with tetryl and with other heat resistant explosives such as DATB and TACOT.* The output of HNS-I in brass confinement is greater than that of tetryl at low pressures and is less than that of DATB and TACOT.

CONCLUSIONS

9. From the results of this test program, it can be concluded that:

a. HNS-I may be considered to be insensitive for all general handling purposes. The precautions normally used for handling intermediate and high explosives should be adequate.

b. Small scale detonation velocity tests in heavy confinement indicate that propagation is supported in column diameters at least as small as 0.1 inch**.

c. Small scale gap tests show HNS-I to have the same sensitivity as DIPAM and to be less sensitive than booster explosives such as tetryl. (This is at the same loading pressure.) As a consequence, HNS-I is insensitive enough to be used beyond the fuze-train interrupter in Navy explosive systems.

On the basis of the above work, and in view of the new process of producing HNS-I from TNT[7], it is recommended that this material be explored for possible use in leads and boosters as a pure explosive or a plastic bonded explosive (PBX).

*TACOT is the trade name of an explosive manufactured by the E. I. duPont deNemours Co.
**Fabrication of HNS-I in MDF has shown propagation in small core loads of less than 2 grs/ft (approx. ".025 column diameter).

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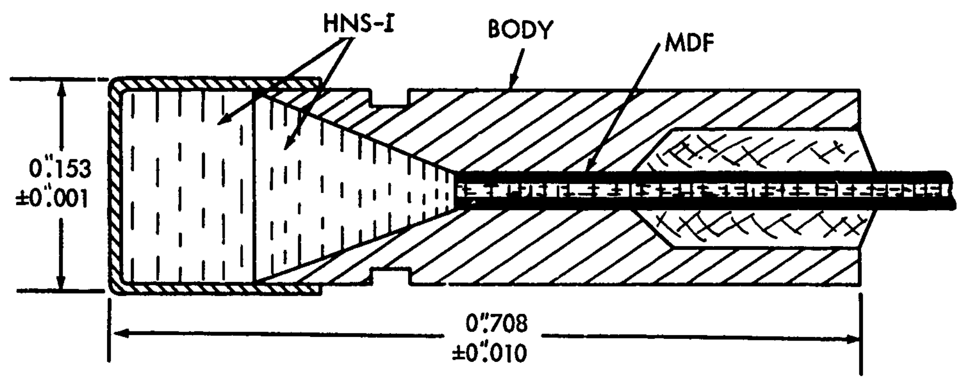

FIG. 1 A TYPICAL MDF END BOOSTER

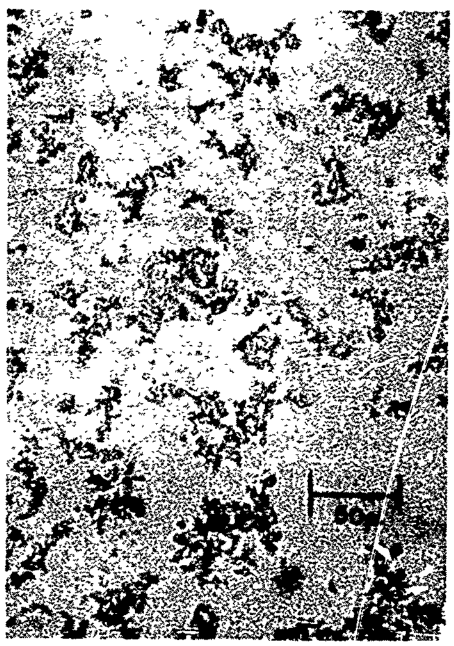

FIG. 2 PHOTOMICROGRAPH OF HEXANITROSTILBENE HNS-I
(NOL SAMPLE NO. X-498)

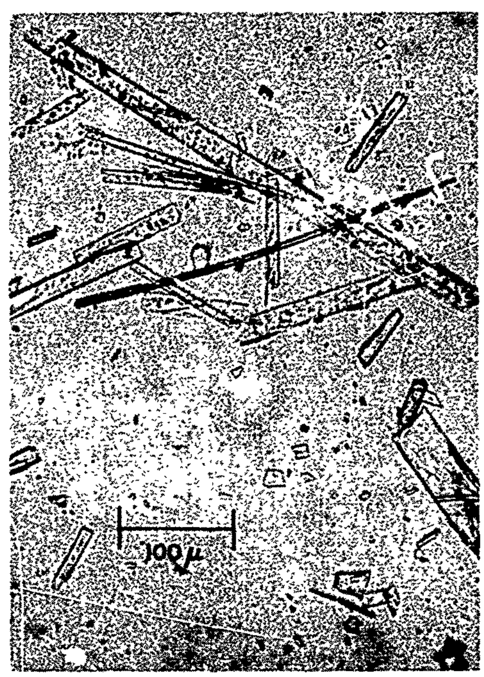

FIG. 3 PHOTOMICROGRAPH OF HEXANITROSTILBENE HNS-R
(NOL SAMPLE NO. X-401)

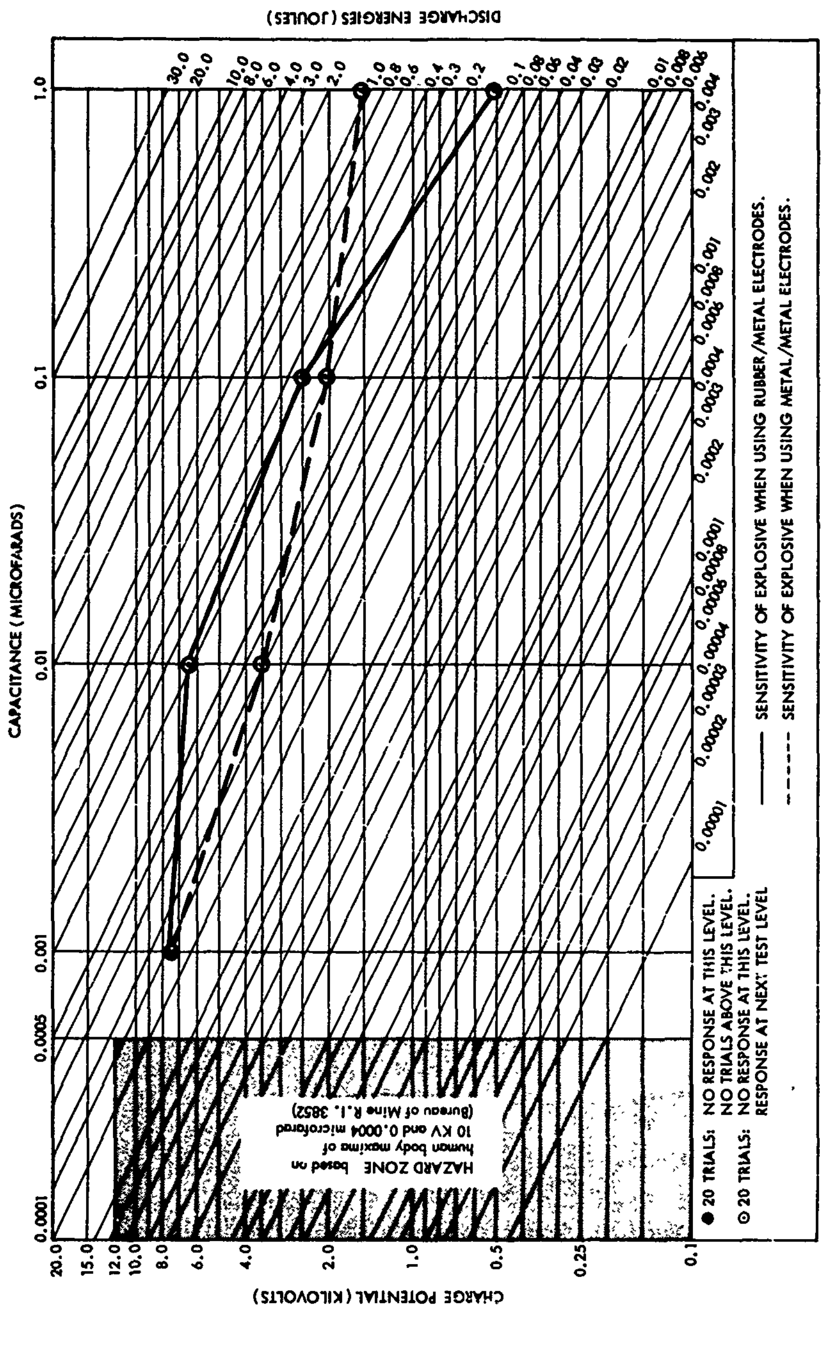

FIG. 4 ELECTROSTATIC SPARK SENSITIVITY TEST FOR HNS-I

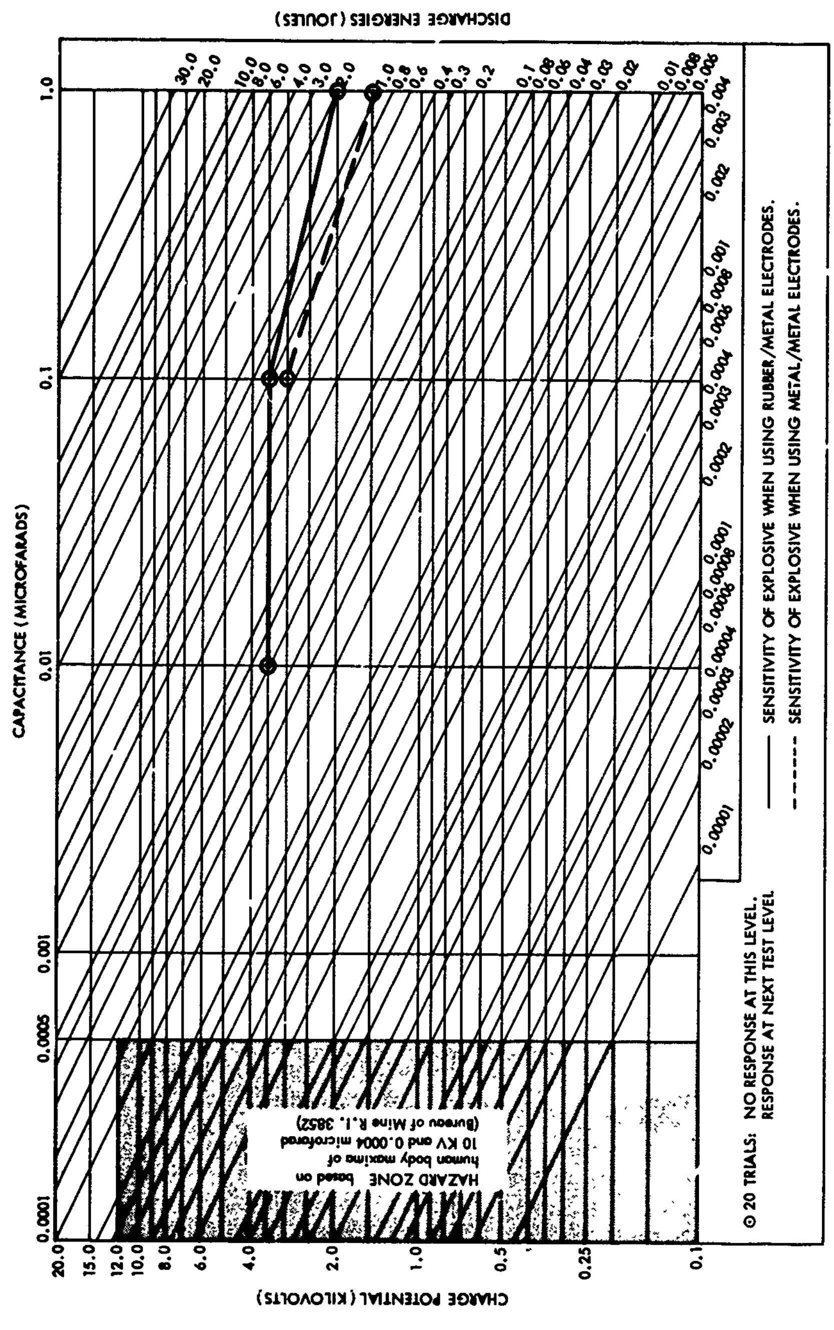

FIG. 5 ELECTROSTATIC SPARK SENSITIVITY TEST FOR HNS-R

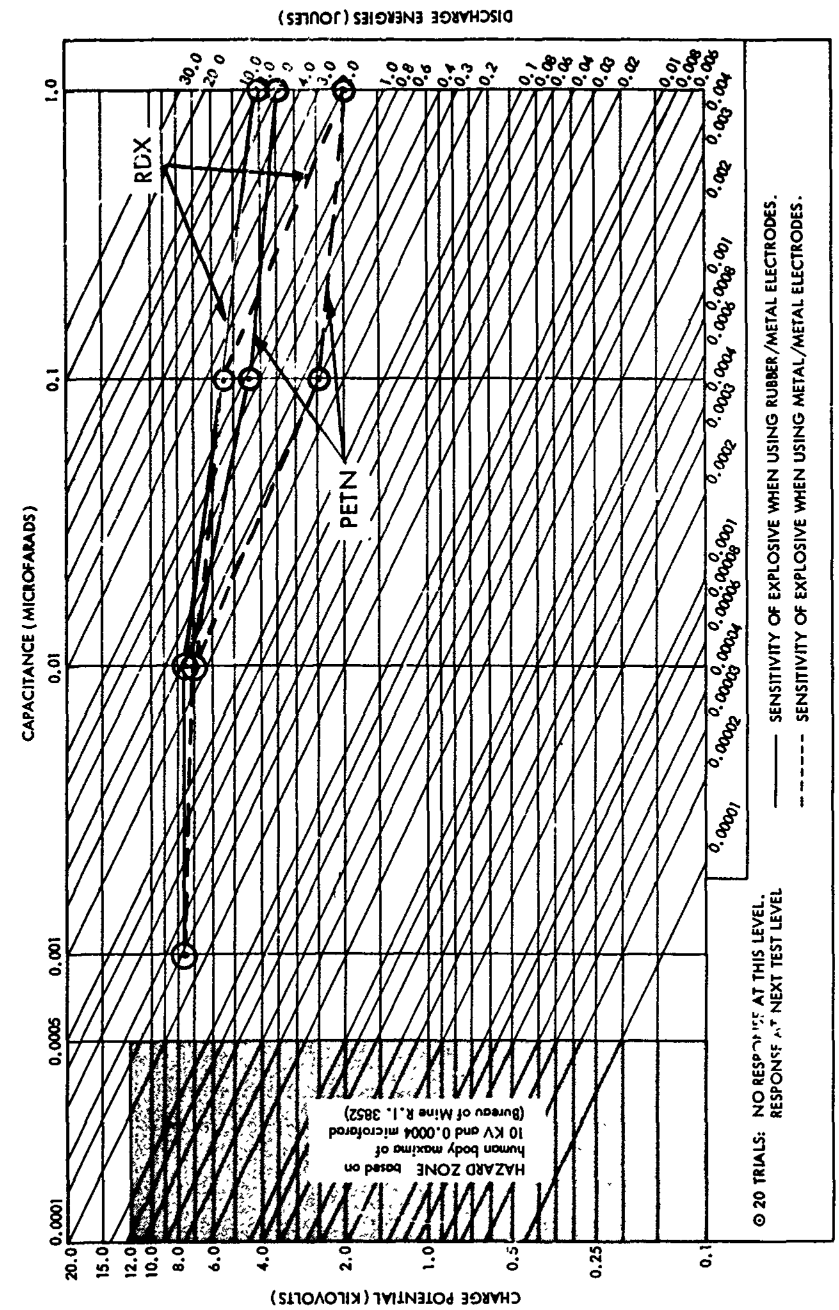

FIG. 6 ELECTROSTATIC SPARK SENSITIVITY TEST FOR PETN AND RDX

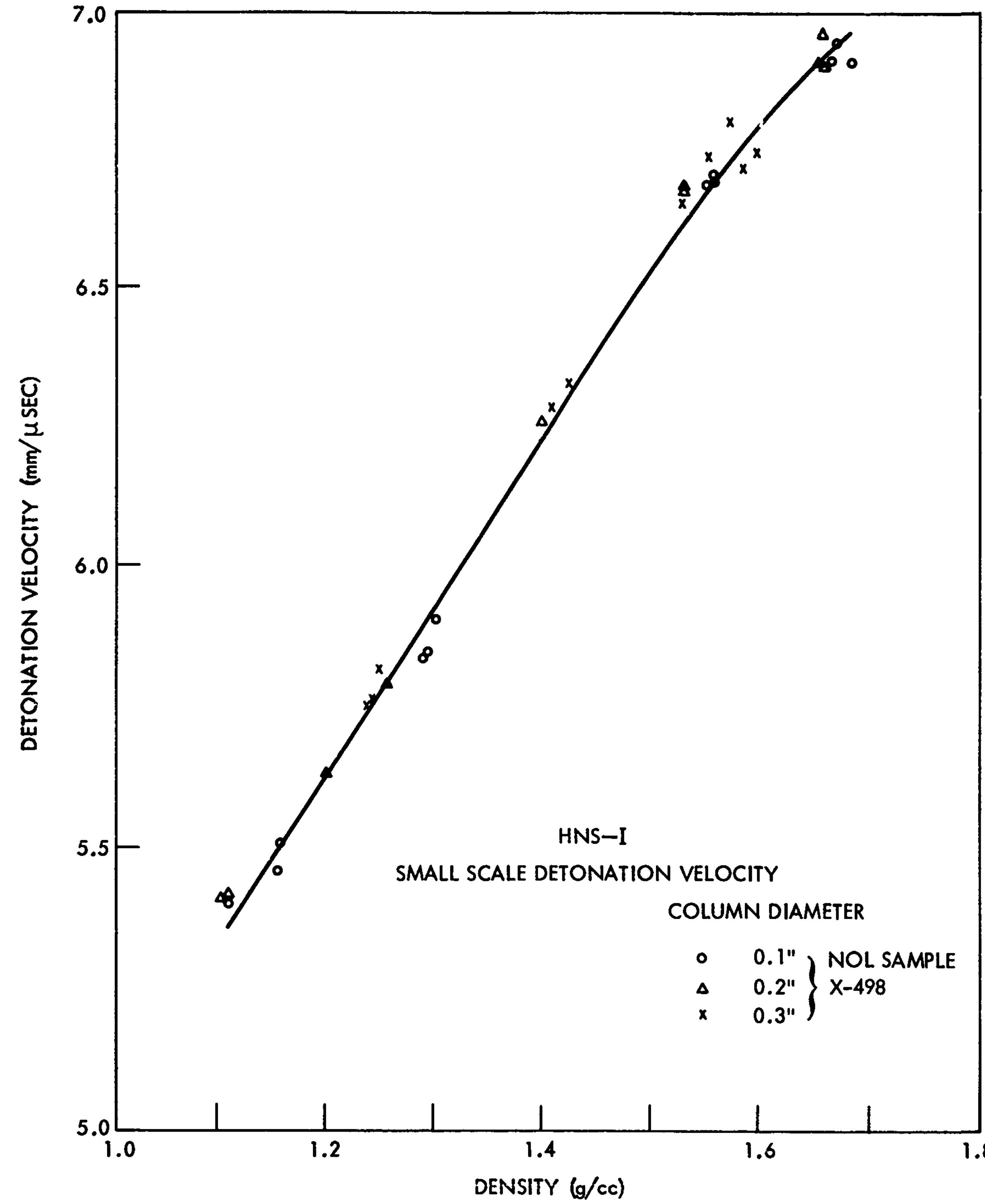

FIG. 7 THE SMALL SCALE DETONATION VELOCITY OF HNS-I AS A FUNCTION OF THE DENSITY AND COLUMN DIAMETER

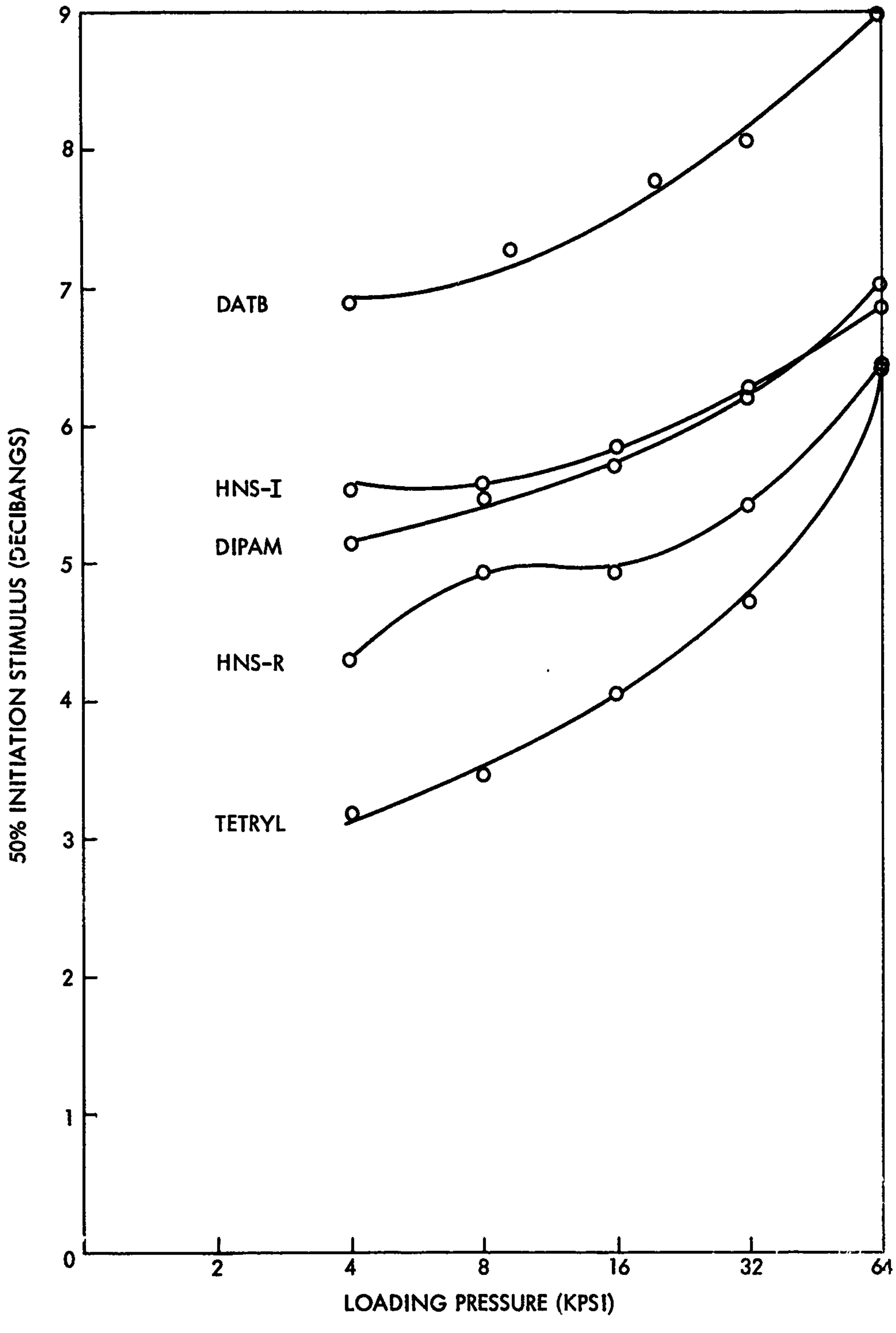

FIG. 8 SMALL SCALE GAP TEST SENSITIVITY VS LOADING PRESSURE OF HNS-I COMPARED WITH OTHER EXPLOSIVES.

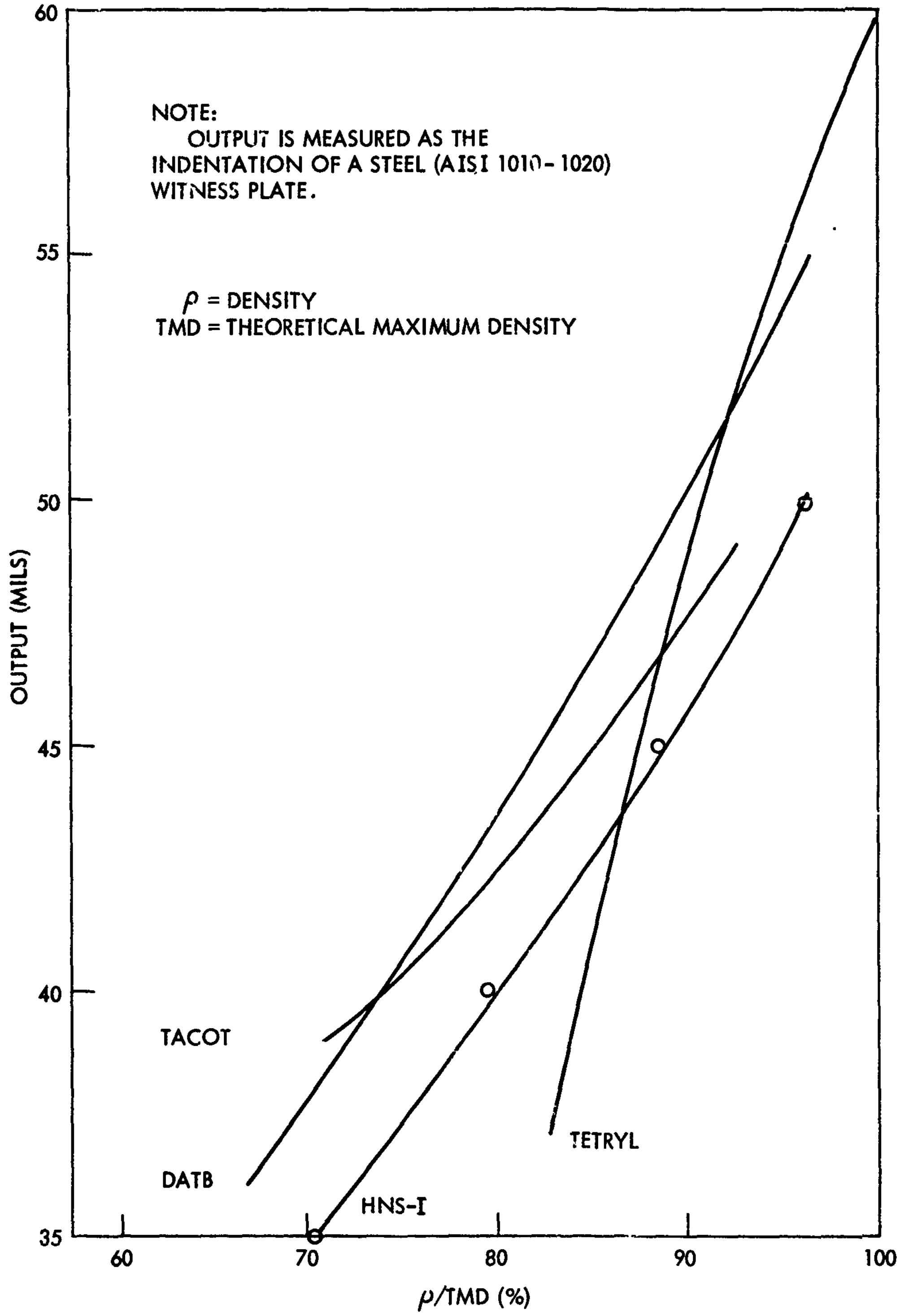

FIG. 9 THE OUTPUT VS DENSITY OF HNS-I AND OTHER EXPLOSIVES

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Couplers, mild detonation fuse						
Fuses, mild detonating						
Fuses, explosives						
Explosives, properties of						
Missiles						
Aircraft, Crew Module						
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